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SOME FEATURES OF THE PHYSIOGRAPHY AND VEGETATION OF THE ALGERIAN SAHARA

By W. A. CANNON, Ph.D.

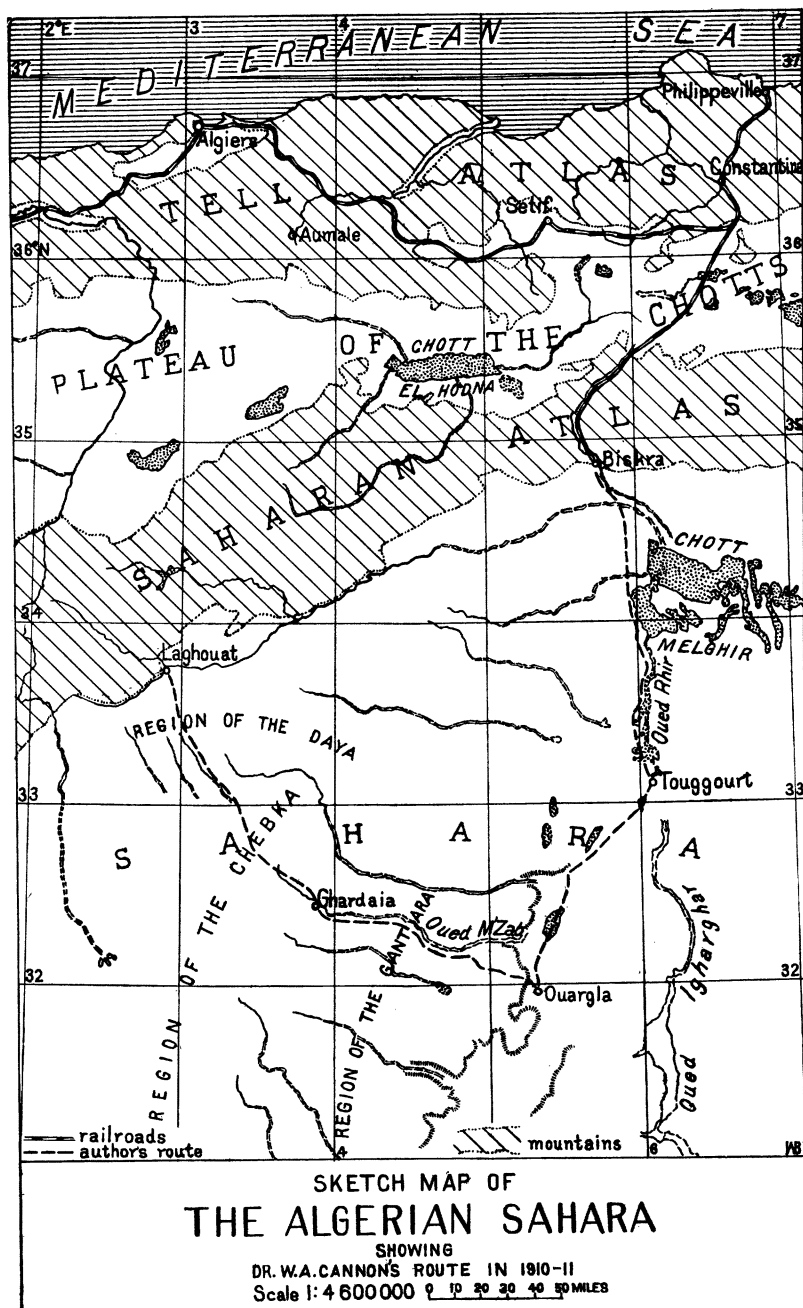
Desert Laboratory, Tucson, Arizona

As a person crosses that portion of Algeria which lies south of the Sahara Atlas Mountains he is struck with the variety of the topographical features of the country, on the one hand, and the sparseness or the plentifulness, as the case may be, of the native flora, on the other, nor, unless a trained student of the desert, is he likely to see that there is any causal relationship between the two. The region to which reference is made, which was visited by the writer in 1910-1911, extends southward from Laghouat* to the M'Zab, of which Ghardaia is the chief town, thence south of east to Ouargla, and thence north to Biskra *via* Touggourt and the Oued Rhir (cf. the map on p. 482).

The Algerian Sahara is divided naturally into large regions, and the basis for the division lies mainly in differences in physiography. There also are minor divisions, founded on soil and surface variations, which may or may not coincide with the limits of the larger regions. Since the Arab, who made these distinctions, is a keen observer of the face of nature, which is usually of vital importance to him, the differences in soil, surface, and topography distinguished by him are generally well grounded.

At least three types of desert are recognized in southern Algeria, which are the *hamada*, or stony desert, the *aureg* or *erg*, the æolian (sandy) desert, and the *reg*, the fluvial, or alluvial desert. There are in addition the *chott*,* or salt spot, which may be of large size, the *daya*, or oasis without constant water supply, and which has no surface drainage. The soil of the *daya*, in distinction to that of the

* The French transliteration of Arabic names used by the author has been retained throughout.
—ED.



chott, however, does not carry an excess of salts. The *oueds*, or arroyos, may be mentioned also since they have distinctive soils as well as characteristic vegetation.

The larger regions are those of the Daya, the Chebka, the Gantara, and the Erg. Some of the general topographical characteristics of each of these regions, together with a few comments on the most noticeable floral features of each, will be given in the following paragraphs.¹

Leaving Laghouat and the Atlas Mountains behind, the traveler enters at once a gently rolling country which is the Region of the Daya. Here the low hills support a scanty population of small shrubs, but, from the hollows (*dayas*), there appear the crowns of well-formed trees. A superficial examination of the surface shows a marked difference between the *dayas* and the upland surrounding them. As has been remarked above, the *dayas* are separate from each other, having no surface drainage. The surface soil of the *dayas* is usually fine, containing an admixture of some sand. Stones are absent. The depth of the soil, also, is apparently considerable, although no exact measurements were made. On the higher ground, between the *dayas*, the soil and the surface are quite different from what is to be seen in the *dayas* themselves. Here sharply angular stones lie fairly thickly on the ground, and, where the infrequent rains have washed the superficial soils away, a light-colored and hard stratum, similar in appearance to the *caliche* of the southwestern United States, is exposed. It is apparent that the entire upland of the Daya Region is underlaid by this impervious hardpan, which has a marked influence on the composition of the flora.

The meager flora of the more elevated portion of the region has already been mentioned. It will be instructive to glance at the vegetation of the depressions. There are two perennials especially characteristic of the *dayas*, which are the betoum (*Pistacia*) and the jujube (*Zizyphus*). The former is a tree and the latter is a shrub. Both of these forms are fitted by root habit to live where the soil is deep, and neither can live where it is shallow. This is in part owing to the relatively large water requirement of the species, and, in part, to the root-systems which are incapable of great variation away from type. In addition to such limitations placed on the distribution, there is also an intimate relation of life-habit of the two forms, which operates to restrict the distribution of one of them. The relation, briefly stated, is as follows: The foliage of the be-

¹ A more complete account will appear in "Botanical Features of the Algerian Sahara," Carnegie Institution of Washington. In press.

toum is abundant and greedily sought by all herbivorous animals. Spines are wholly absent. It is only the adult plant, or, at any rate, the plant so high as to have its crown beyond the reach of animals, wild as well as domestic, that can successfully withstand their attacks. The young betoum would never survive were it not for the fact that it is always protected by another species, which is not eaten by animals; such a protector in the present case is the jujube. This shrub has small, leathery leaves and, moreover, is well provided with stout and sharp pines. When seeds of the betoum fall within the jujube's extending branches, they may sprout and grow to become fairly large trees before being discovered. When this occurs, if the jujube is sufficiently large so as to repel the animals, or if the young tree itself is of good size, its survival is assured. So important is the relation sketched to the betoum that that species does not occur in dayas where its nurse is not also to be found, and, also, its distribution throughout the region is strictly conditioned on the parallel distribution of the jujube.

Continuing south through the Region of the Daya, the Chebka is reached, where the topography undergoes a marked change. In place of the monotonous and undulating plain without well-developed drainage, which characterizes the Daya Region, oueds are encountered and low mountains, flat-topped, running in various directions. The rather confused topography of the region suggests, in bird's-eye view, a net, hence the name, Chebka. As the southern portion of the Chebka is approached the valleys are seen to become continuously wider until, near Ghardaia, they constitute the larger part of the surface. Here the physiography is a resemblance, in miniature, of the mesas and mountains of southern Arizona.

The flora of the Chebka is less diversified than that of the Daya and less rich. A casual view of the broad valleys, really hamada, does not reveal the presence of any plant, but instead a gray-brown expanse, with stones and even boulders covering the surface. In slight depressions, or in larger drainage channels, however, where there is a greater accumulation of earth, grasses, dry and brown most of the year, and small shrubs are to be found. A careful examination of the other portions of the hamada, where the available soil is very shallow and is underlaid by an impervious substratum, as in the Daya Region, shows that here also a few plants are able to survive. Such an area is figured in detail in Figure 11, which shows the character of the species, mainly *Haloxylon* and a few grasses. The number as well as position of the plants of the area are shown in Figure 9, a map of the area photographed. The

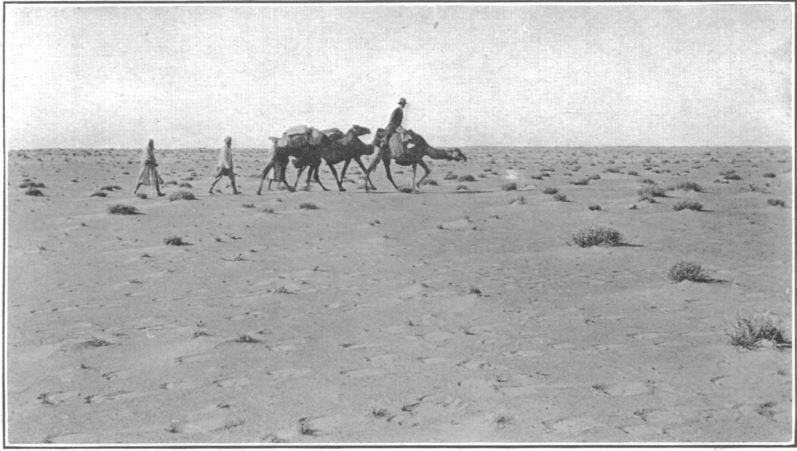


FIG. 1—*Reg* desert, 140 kilometers north of Ouargla. At the place a light covering of sand provides a mulch which operates to prevent rapid drying of the underlying soil.

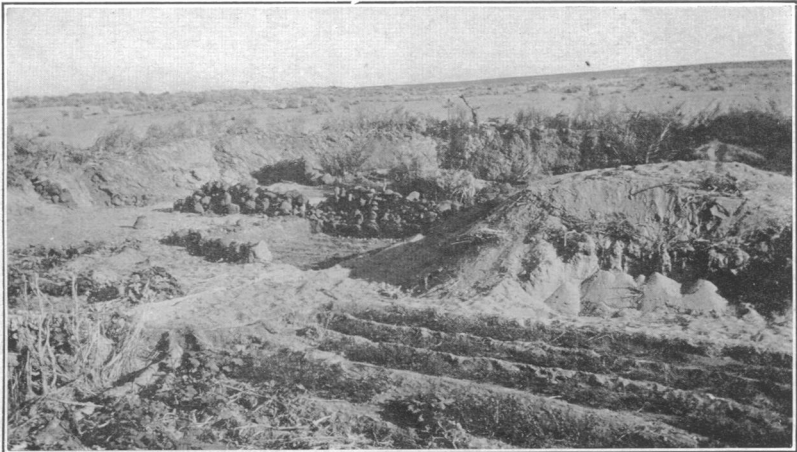


FIG. 2—A new garden on the *reg* desert, 32 kilometers north of Ouargla. Here the soil is deep and fine grained, and the water from which the garden is irrigated is not over 1 meter beneath the surface.

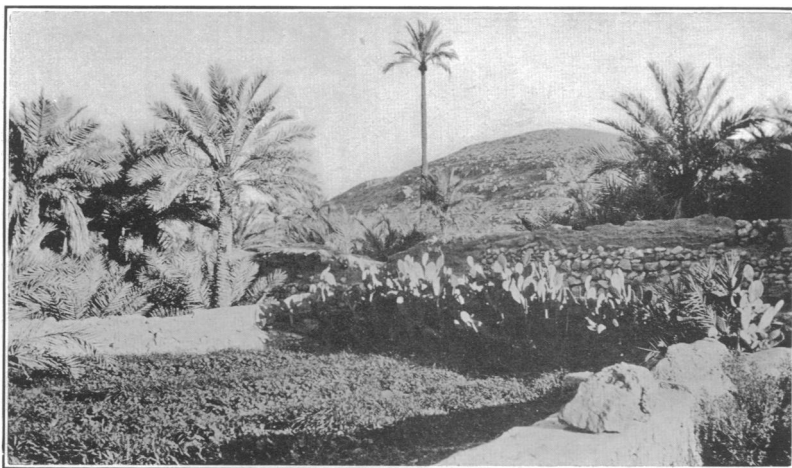


FIG. 3—The corner of a garden at Ghardaia where barley is raised. The Barbary fig, shown in the middle ground, does not escape from the irrigated land, owing to the extreme dryness of the natural soil. It is not the extreme type of a desert plant.



FIG. 4—An irrigating ditch at Ghardaia. Water is drawn from wells in skin buckets and stored in plastered cisterns, from which it is distributed by such laterals as shown in this figure.

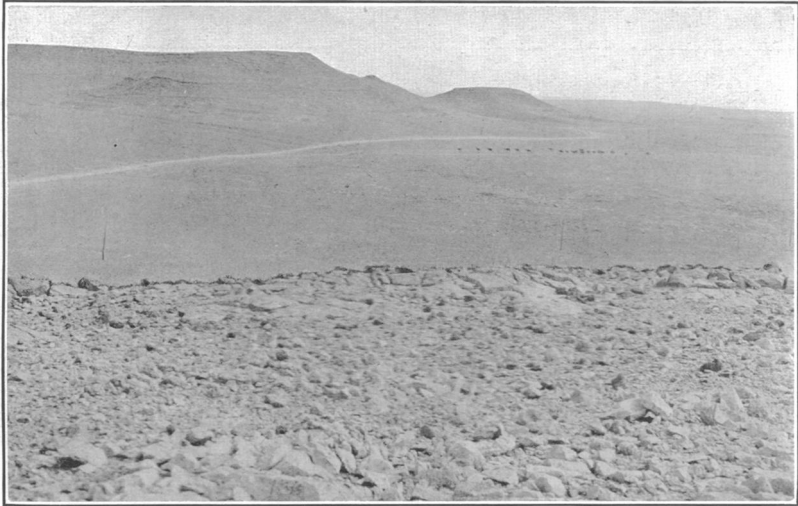


FIG. 5—View in the Region of the Chebka near Ghardaia. The broad plain is really a *hamada* desert, characterized by thin soil, which is underlaid by hardpan, and sparse vegetation.

Of the different physiographic divisions of southern Algeria, the *hamada* is the most arid. It is the desert *par excellence*.

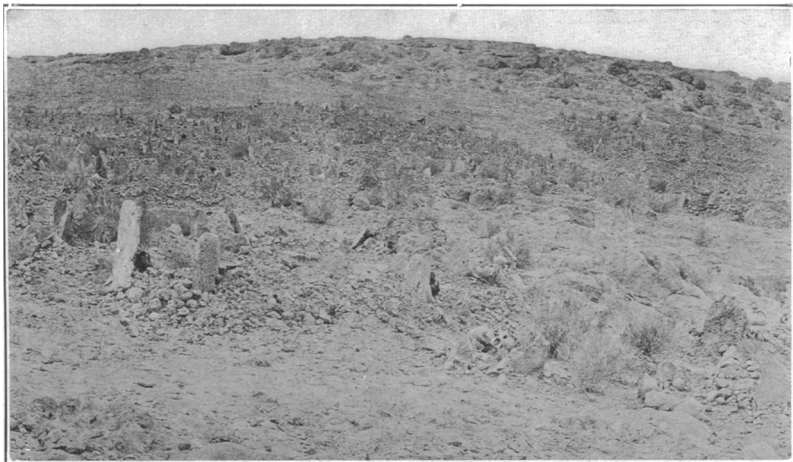


FIG. 6—A corner of an Arab cemetery at Ghardaia. The small shrub among the rough headstones is *Haloxylon*, an unarmed species, but widely distributed through southern Algeria. It is much sought after by all herbivorous animals as a food.

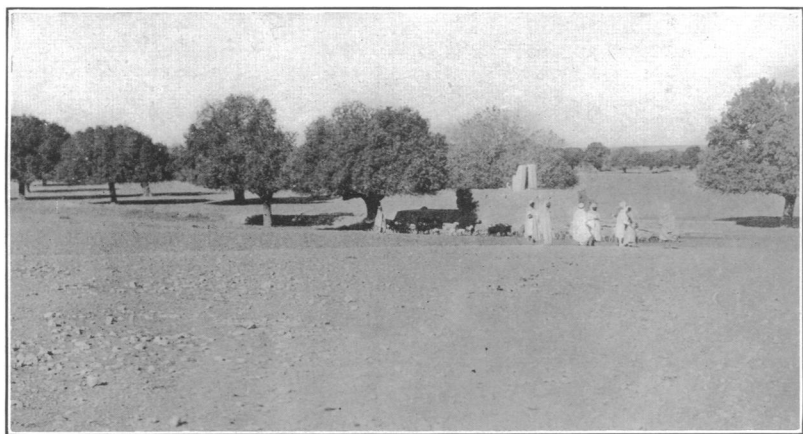


FIG. 7—View in a *daya* south of Laghouat. The trees shown are native species of *Pistacia* which have grown without irrigation, although the rainfall is less than 8 inches annually.

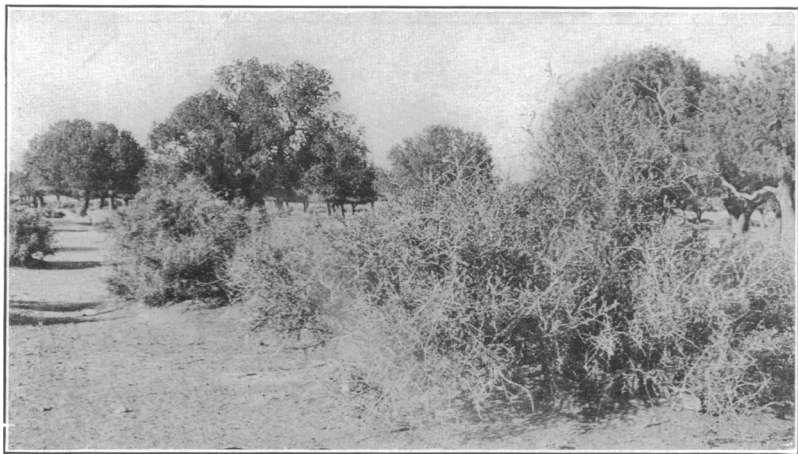


FIG. 8—The jujube (*Zizyphus*) in a *daya* south of Laghouat. This species serves as nurse to the tree (*Pistacia*) shown in the background, protecting it when young against the attacks of animals. The local distribution of the *Pistacia* is conditioned on that of the jujube, as survival independent of it is impossible.

square in question, 50 by 50 feet, was selected as representing the richest flora of the hamada. Through the center of it runs a depression, possibly 6 inches lower than the sides of the square, where the earth has lodged, and where water from the infrequent rains courses. The sides of the figure represent the average condition on the hamada. It is interesting to note that the dominant species on the area, *Haloxylon*, is eaten by animals, and that in

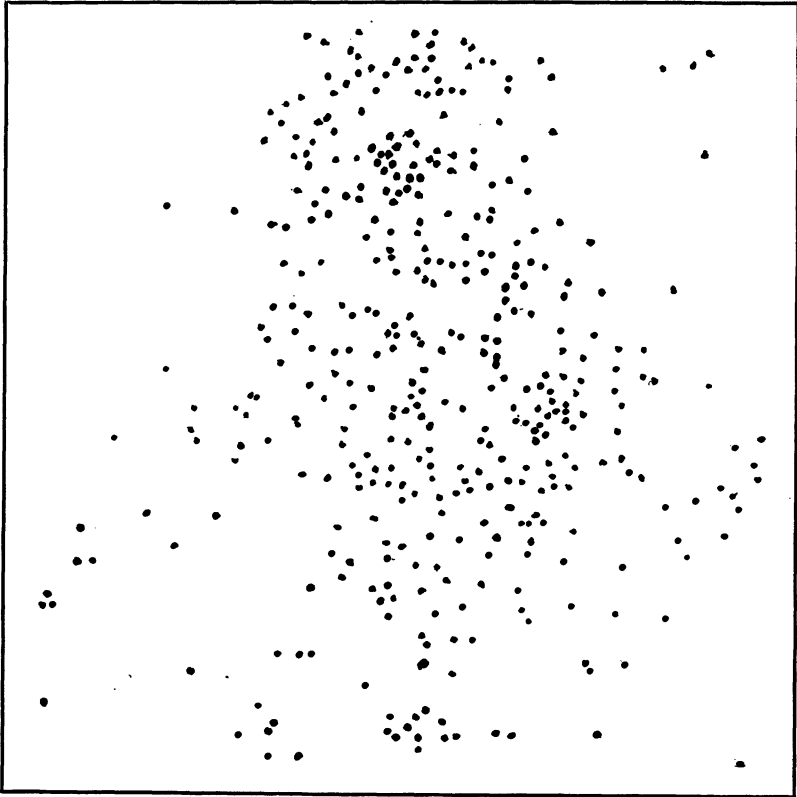


FIG. 9.—Diagram showing the number and the position of the plants in an area 50 feet square in the *hamada* near Ghardaia. Each dot represents a living perennial.

spite of this fact it is one of the most widely distributed species in the northern Sahara. Several thousand sheep, goats, camels, as well as the wild gazelle, find all or most of their living on such pastures as is shown in the plate.

There is an important oued at Ghardaia, the Oued M'Zab, which is only mentioned here to point to the differences in soil conditions and plant inhabitants which distinguish the flood-plain of

the oued from the same features on the neighboring hamada. The soil of the Oued M'Zab valley is extremely variable. Close to the oued it is sandy at the surface and gravelly beneath. Near the valley sides the surface soil is fine clay with an admixture of sand. A hardpan in places comes within 3 or 4 inches of the surface, and in places crops out. Here the natives thresh the small amount of barley they are able to grow in their diminutive fields. In places, however, the fine soil is deeper, and the hardpan is either absent, or a considerable distance beneath the surface. In certain areas sand is strewn over the valley, either as a fine mulch, or as rather low dunes. Such being in brief the most striking soil conditions of the valley, the plants may be as briefly characterized. Along the oued occurs *Tamarix*—this species being met in no other place. Where the superficial soil is most shallow, either there are no plants at all, or *Haloxylon* is the leading species, if not the only one. Where the soil is either fairly deep, or is covered with a mulch of sand, other species than those mentioned occur in fair profusion.

Upon leaving Ghardaia and the Chebka the physiography of the country undergoes, quickly and strikingly, another change. The broad valleys with low mountains, characteristic, as we have seen, of the southern portion of the Chebka, give way, and there begins a wide plain broken by no heights and crossed by no important oueds, which, apparently quite flat, is, in reality, slightly undulating. This is the hamada *par excellence*, the Gantara. The surface recalls that of the Daya Region, save that the elevations are not so high and the depressions not so large or so deep. It, thus, is a region of rather shallow and small hollows, possibly formed by air currents mainly, which are not confluent. The surface of the ground is strewn with angular stones, and the soil available for the roots of plants is very thin. A hardpan underlies the region and is in places exposed.

The plant life of the Gantara is very sparse, being, if possible, more meager than that of the Chebka. Neither the hollows nor the more elevated areas are favorable for the presence of much vegetation. In certain areas, however, as midway between Ghardaia and Ouargla, where the surface is fairly level, there are a larger number of perennials than a hasty glance would suggest. For example, on an area 50 feet square, 389 living perennials were counted, all of which were small. The explanation of the paradox, a large population because of the poor water supply, is to be found in the dwarfing effect of the arid climate by which a small demand

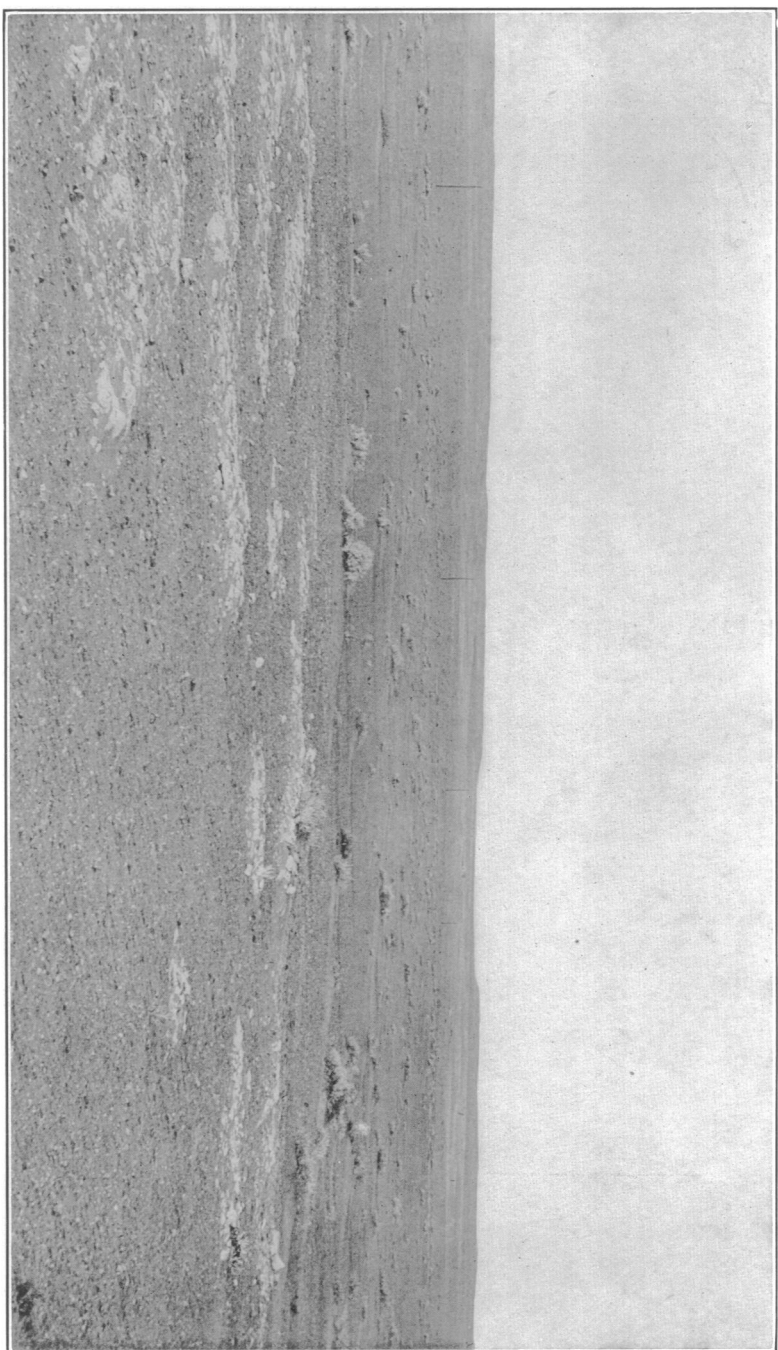


FIG. 10—Looking toward the *reg* desert, shown in the middle ground, north of Ouargla. The background is the eastern edge of the Gantara.

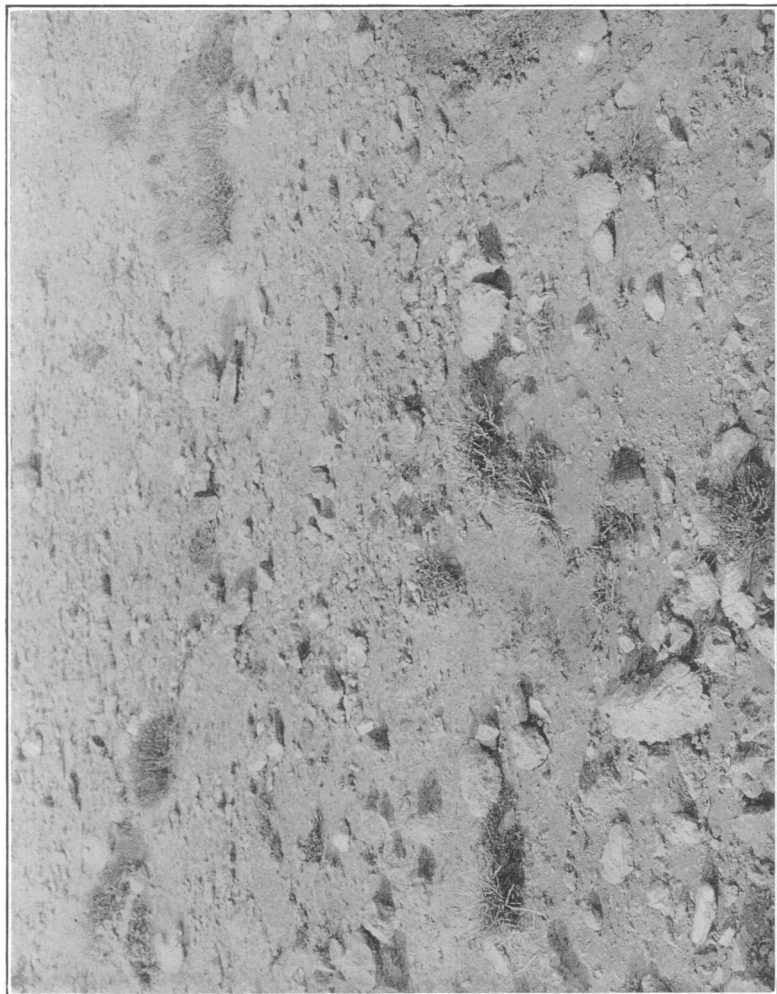


FIG. 11.—View, showing detail, in the square on the *hamada* near Chardaiia. The number and distribution of the plants of the area are given in the text figure. The largest shrub is *Haloxylon*. Grasses are also present.

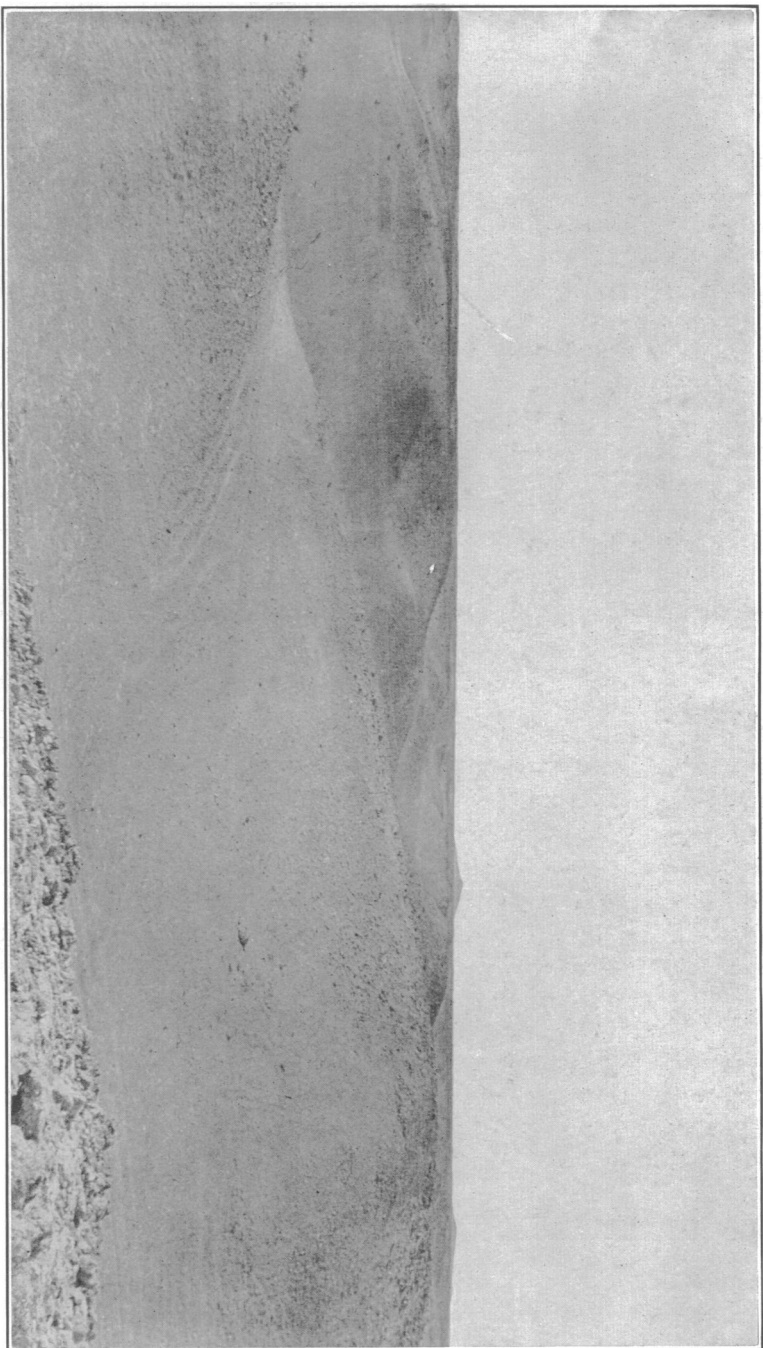


FIG. 12.—*Mamelons* approaching Chott Mellala near Ouargla. The high sand hills in the *chott* appear on the horizon. The *mamelons* are largely the result of wind erosion.

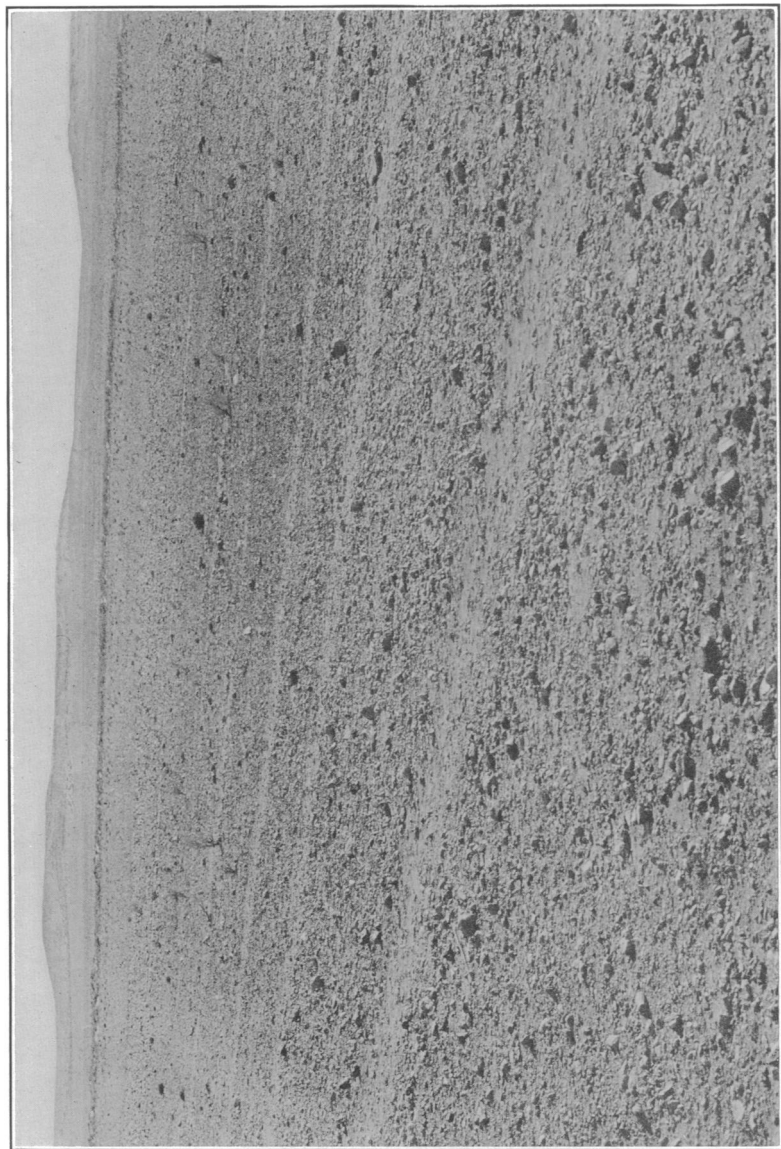


FIG. 13.—Detail of the surface on the northern edge of the Gantara. The most southern mountains of the Chebka are shown in the background. Camel trails, the only "roads" connecting Ghardaia, Ouargla and Touggourt, are seen crossing the middle ground.

is made for root room and for water. Where the soil is deeper, the same shrubs are larger, and, therefore, the population is less.

We crossed on the Gantara two barren zones, where, so far as we could determine from inspection, the surface and soil were similar to the surface and soil of the square above mentioned. Not a plant could be found, however, and it was apparent that on these zones less water had fallen than on the other area referred to. We were unable to find any reason for the condition observed.

Two chotts were crossed in the Gantara, of which one is about 10 kilometers wide. This, the Chott Mellala, is flooded at rare intervals. There are no plants in the central portion of the chott, but salt-resistant species, such as *Ephedra* and forms that are marked halophytes, occur on the borders. Along the eastern side lies a chain of dunes, which are said to be the highest in Algeria, 750 feet high. The wind-blown and sharp ridges support no plants, but toward the base occurs a sparse population of such perennials, like *Tamarisk*, *Ephedra* and "drinn" (*Aristida pungens*), which inhabit similar areas in other portions of southern Algeria.

The floor of the chott mentioned above, as well as the general level of the Ouargla plain, is about 180 feet lower than the Gantara. The dividing zone consists of points which project from the Gantara, or of isolated hills, whose connection with the Gantara has been lost. The hills are conical in form, *mamelons*, and show the effect of wind action. Characteristic *mamelons* situated on the western side of the Chott Melalla are shown in Figure 12.

East of both the Daya and the Chebka Regions is a region lower in altitude, some of it being, in fact, below sea level, which is a mingling of several physiographical features, and which is not designated by a name. Generally speaking, it is directly, or indirectly, connected with the drainage system of the Oued Igharghar, which takes its origin about 900 miles south in the Ahaggar Plateau (23° N.) and is the most important oued in the western part of the Sahara. Ouargla, Touggourt and the Oued Rhir, all celebrated for fine dates, are situated in the Igharghar drainage. To the east of these localities and oases lies a vast sandy desert only the edges of which are seen by the traveler in going northward from Ouargla. The northern extension of the Igharghar consists of immense chotts. Besides these physiographic areas there is that of the flats along the oued, or forming a portion of the oued, and which constitute a reg desert. There should be mentioned also the occasional approach of the hamada on the eastern side of the

reg, and this, as well as the reg also, is in places covered by large dunes or, at least, by drifting sand.

One of the characters of the Daya and the Chebka which has not been mentioned is the great depth to a perennial supply of water. On the hamada water has never been found, and in the dayas it lies from 100 to about 400 feet deep. In the valley of the Oued M'Zab at Ghardaia, the water is usually more than 50 feet beneath the surface. In these instances the water is too deep to be reached by the roots of plants and, therefore, does not influence the character of the vegetation. But in the reg desert to the north of Ouargla, as well as near that oasis, the upper level of the ground-water often lies within 3 feet of the surface. Where the ground is more elevated the depth, naturally, is more than this. The water, however, is highly charged with salts, but is consumed by animals as well as by the Arabs. Plants, therefore, that can endure such salts as the water carries have an abundant water supply. It is not surprising as a consequence that the reg, with deep soil and much water, has a fairly rich flora. Nowhere, indeed, can there be a better demonstration of the direct influence of abundant and available water supplied to the roots, although the rainfall of the region and other factors making for aridity unite to make it one of the most arid regions conceivable. As soon, however, as one retreats from the reg to the hamada, where the soil conditions and the water relations also are quite different, plants are almost wholly wanting.

A similar contrast is to be found in the vicinity of Biskra, although, owing to a fairly large rainfall in the Biskra region, the flora is not so meager as farther to the south.

In the Algerian Sahara, as indeed in other arid regions, there is a very close association between the character of the flora and the nature of the soils, especially their depth. Aside from the amount of annual precipitation there is probably no factor influencing the natural vegetation as important as this one. Thus in the present paper it has repeatedly been shown that, given two areas with the same rainfall, the one with shallow and the other with deep soil, the latter area has the richer flora, and the kinds of plants which occupy the two areas are usually unlike. Taking up the last condition first, it is found that such plants as have roots capable of variation away from type, or such as have a widely reaching root-system, are to be found where the soil is most shallow, while, on the other hand, plants with deeply penetrating roots, incapable of great variation away from type, or such as can

accommodate themselves to deep soil, occur on areas where the soil available for roots is actually or relatively deep. Finally, the sparseness of plants on the hamada is associated with the wide extent of the root-systems by which neighboring plants compete for the water. In certain instances, however, as on the Gantara, where the soil is shallow and the climate intensely arid, the shoots are dwarfed, and probably the root-systems as well, so that more individuals can occupy a given area than otherwise would be the case. This is one of the oddest paradoxes to be met in the desert, that the number of individuals is increased because the soil is shallow and the climate arid.